IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

HAREN S. GANDHI ET AL.

Group Art Unit: 1764

Examiner: Hien Thi Tran

Serial No.: 10/065,470

Filed: October 22, 2005

For: CATALYST SYSTEM FOR THE REDUCTION OF NO_x AND NH_2 EMISSIONS

Attorney Docket No.: FCHM 0119 PUS / 81045602

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an Appeal Brief in support of the appeal from the final rejection of claims 1-31, 33, and 39 of the Office Action mailed on July 5, 2006 for the above-identified patent application.

I. REAL PARTY IN INTEREST

The real party in interest is Ford Global Technologies, L.L.C. ("Assignee"), a corporation organized and existing under the laws of the state of Delaware, and having a place of business at One Parklane Boulevard, Suite 600, Parklane Towers, East, Dearborn, Michigan as set forth in the assignment recorded in the U.S. Patent and Trademark Office on November 21, 2001 at Reel 013257/Frame 0219.

II. RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to the Appellants, the Appellants' legal representative, or the Assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1-31 and 33-39 are pending in this application. Claims 36-38 have been withdrawn from consideration. Claim 34 has been cancelled. Claims 24-29 and 39 are being cancelled herewith. Claims 1-23, 30-33 and 35 have been rejected and are the subject of this appeal.

IV. STATUS OF AMENDMENTS

No response after final rejection has been filed.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The subject matter pertains to a catalyst system to facilitate the reduction of nitrogen oxides (NO_X) and ammonia (NH_3) from an exhaust gas, especially exhaust gases produced by an engine operating under lean air/fuel conditions (a ratio that is greater than the stoichiometric ratio of 14.6).

As a result of increasingly stringent fuel economy and emission standards for car and truck applications, it is preferable to operate an engine under lean air/fuel ratios. While lean operation improves fuel economy, operating under lean conditions increases the difficulty in treating some polluting gases, especially NO_x. For NO_x reduction under lean conditions, lean NO_x adsorber (trap) technologies have been widely utilized.

Lean NO_x adsorbers operate in a cyclic fashion of lean and rich durations. The lean NO_x trap functions by adsorbing NO_x when the engine is running under lean conditions

– until the NO_x trap reaches the effective storage limit – followed by NO_x reduction when the engine is running under rich conditions. During this rich cycle, a short rich pulse of reductants, carbon monoxide, hydrogen and hydrocarbons reduces the NO_x adsorbed by the trap during the lean cycle. The reduction caused during the rich cycle purges the lean NO_x adsorber, and the lean NO_x adsorber is then immediately available for the next lean NO_x storage/rich NO_x reduction cycle. Lean NO_x traps, however, often have the problem of low NO_x conversion; that is, a high percentage of the NO_x slips through the trap. (Page 2, ll. 6-33.)

NO_x slip can occur either during the lean portion of the cycle or during the rich portion of the cycle. Lean NO_x slip is often called "NO_x breakthrough." It occurs during extended lean operation and is related to saturation of the NO_x trap capacity. Rich NO_x slip is often called a "NO_x spike." It occurs during the short period in which the NO_x trap transitions from lean to rich and is related to the release of stored NOx without reduction. Test results depicted in Figure 1a have shown that during this lean-rich transition, NOx spikes, the large peaks of unreacted NO_x, accounts for approximately 73% of the total NOx emitted during the operation of a lean NO_x trap. NO_x breakthrough accounts for the remaining 27% of the NO_x emitted. (Page 1, l. 31 - page 2, l. 13.)

An additional problem with lean NO_x traps arise as a result of the generation of ammonia by the lean NO_x trap. As depicted in Figure 1b, ammonia is emitted into the atmosphere during rich pulses of the lean NO_x adsorber but the NO_x conversion problem is magnified for diesel vehicles, which require more than a 90% NO_x conversion rate under the 2007 U.S. Tier II BIN 5 Emission Standards at temperatures as low as 200°C. While high NO_x activity is possible at 200°C, it requires extreme measures such as shortening the lean time, lengthening the rich purge time, and invoking very rich air/fuel ratios. All three of these measures, however, result in an increased formation of ammonia. Accordingly, while it may be possible to achieve 90+% gross NO_x conversion (the percentage of NO_x that is reduced to

N_2, N_2O and NH_3), there has not been a viable solution to achieve 90+% net NO_x conversion (the percentage of NO_x that is reduced to nitrogen, N_2, only).

Accordingly, a catalyst system that (1) reduces NO_X breakthrough and NO_X spikes from a lean NO_X trap; (2) improves net NO_X conversion; and (3) reduces NH_3 emissions would be useful. As a result, in the claimed catalyst system, net NO_x conversion is improved and ammonia emissions reduced through the use of a lean NO_x trap that is modified to optimize ammonia generation and a NH_3-SCR catalyst system, which operates together to produce and store ammonia and reduce NO_x to nitrogen.

Claim 1 recites an emission control system for controlling NO_X and NH_3 emissions from an exhaust gas stream, which includes a lean NO_X trap in communication with the exhaust stream, wherein the lean NO_X trap is optimized for NH_3 generation by removing oxygen storage capacity of the lean NO_X trap. The emission control system also includes an NH_3-SCR catalyst in communication with the exhaust stream for adsorbing the NH_3 generated by the lean NO_X trap, so it can then react with NO_X in the exhaust stream during lean conditions to improve net NO_X conversion and reduce ammonia emissions.

Claim 20 recites an emission control system for controlling NO_X and NH_3 emissions that includes a lean NO_X trap in communication with the exhaust stream, wherein the lean NO_X trap comprises a lean NO_X trap formulation which includes one or more NO_X storage and NH_3 generating materials; and a NH_3-SCR catalyst in communication with the exhaust stream for adsorbing NH_3, wherein the NH_3-SCR catalyst comprises a NH_3-SCR catalyst formulation which includes one or more NH_3 adsorbing materials; and wherein the lean NO_X trap formulation and the NH_3-SCR catalyst formulation are placed on one substrate.

Claim 30 recites an emission control system for controlling NO_X and NH_3 emissions that comprises a lean NO_X trap in communication with the exhaust stream to provide

a NO_X reducing exhaust stream including NO_X and NH_3, wherein the lean NO_X trap is optimized for NH_3 generation by removing oxygen storage capacity; and an NH_3-SCR catalyst is also included in communication with the exhaust stream for adsorbing NH_3, so that the NH_3 adsorbed by the NH_3-SCR catalyst reacts with NO_X to improve the reduction of NO_X and NH_3.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 9-12, 14-17, 19, 30-31 and 33 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Kinugasa et al. (U.S. Patent No. 6,109,024).

Claims 2-8, 18 and 20-23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kinugasa et al. (U.S. Patent No. 6,109,024) in view of Fuwa et al. (U.S. Patent No. 6,345,496).

Finally, claims 13 and 35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kinugasa et al. (U.S. Patent No. 6,109,024) in view of Yamada et al. (U.S. Patent No. 6,221,804).

VII. ARGUMENT

A. Claims 1, 9-12, 14-17, 19, 30-31 And 33 Are Patentable Under 35 U.S.C. § 102(b) Over Kinugasa et al. (U.S. Patent No. 6,109,024)

Kinugasa describes an emission control device that includes the adjustment of the lean to rich air/fuel ratio of the exhaust gas by a fuel injection technique to convert some NO_X to NH_3, which can be accomplished by a three way catalyst or a NO_X adsorbing-reducing catalyst. (Col. 3, ll. 11-42.) More specifically, Kinugasa states that an exhaust gas with a rich air/fuel ratio which contains a relatively large amount of NO_X is formed in the cylinder by direct cylinder fuel injection during the expansion or the exhaust stroke of the engine. (Col.

3, ll. 27-31.) Kinugasa then continues that "[t]his exhaust gas, having a rich air-fuel ratio and containing a relatively large amount of NO_X, is supplied to the NH_3 conversion means such as a three way catalyst or a NO_X adsorbing-reducing catalyst. Since the amount of NO_X in the exhaust gas is large, a large amount of NH_3 is produced by the NH_3 conversion means and is supplied to the purification means. Therefore, a sufficient amount of NH_3 for reducing NO_X in exhaust gas is supplied to the purification means." (Col. 3, ll. 35-42.) In sum, Kinugasa relies on the creation of a rich air/fuel ratio to generate a large amount of NO_x in the exhaust gas which in turn would produce a large amount of NH_3 when supplied to a three-way catalyst or a NO_x adsorbing-reducing catalyst.

In contrast, with the claimed subject matter, the lean NO_X trap itself is optimized for NH_3 generation by removing oxygen storage capacity of the lean NO_X trap and thus NH_3 is purposely generated by the lean NO_X trap for adsorption by the NH_3-SCR catalyst. This reservoir of adsorbed ammonia in the NH_3-SCR catalyst is then used to react directly with the NO_x emitted from the lean NO_X trap to improve overall net NO_X conversion — a rich air/fuel ratio does not need to be created. Kinugasa, however, never discloses any teaching to modify the lean NO_x trap to increase NH_3 production and in turn improve net NO_x conversion.

The Examiner relies on Col. 8, ll. 37-43 and ll. 61-67 as evidence that Kinugasa discloses a lean NO_X trap that is optimized for NH_3 generation by removing oxygen storage capacity. However, the cited lines state as follows:

> On the other hand, when the oxygen concentration and the exhaust gas becomes low, i.e., when the excess air ratio λ of the exhaust gas becomes $\lambda \leq 1.0$, the production of NO_2 on the surface of the platinum Pt is lowered and the reaction proceeds in an inverse direction ($NO_3^- \rightarrow NO_2$), and thus nitric acid ions NO_3^- in the catalyst are released, in the form of NO_2, from the NO_X absorbing-reducing catalyst 7.
>
> (Kinugasa, col. 8, ll. 37-43.)

> In addition, the NO_X adsorbing-reducing catalyst also converts NO_X and the exhaust gas to NH_3 by a mechanism exactly the same as that of the three-way catalyst. Therefore, a NO_X adsorbing-reducing catalyst can be used as the NH_3 conversion means in lieu of the three-way catalyst. Embodiments in which the NO_X absorbing-reducing catalyst is used as the NH_3 conversion means will be explained later.
>
> (Kinugasa, col. 8, ll. 61-67.)

Nothing in the above quoted Kinugasa sections teach that the lean NO_x trap should be modified by removing oxygen storage capacity to intentionally optimize NH_3 generation and in turn improve net NO_x conversion.[1]

Kinugasa makes no mention of oxygen storage capacity or the use of a modified lean NO_x trap to purposely increase NH_3 production. Accordingly, Kinugasa fails to teach the use of a lean NO_X trap that has been enhanced for NH_3 production in combination with an NH_3-SCR catalyst, and thus independent claims 1 and 30 along with dependent claims 9-12, 14-17, 19, 31 and 33 are allowable under 35 U.S.C. § 102(b) over Kinugasa et al.

B. Claims 2-8, 18 And 20-23 Are Patentable Over Kinugasa, U.S. Patent No. 6,109,024, In View Of Fuwa et al., U.S. Patent No. 6,345,496

As set forth above in reference to independent claim 1, as the Kinugasa et al. reference fails to disclose an emission system wherein the lean NO_X trap is optimized for ammonia generation, dependent claims 2-8 and 18 are allowable for the reasons stated.

[1] As is well known in the art, the amount of oxygen reversibly provided in and removed from the gas phase of a particular component is called oxygen storage capacity. Cerium oxide is a frequently used oxygen storing component, as are other materials such as NiO and FeO.

Independent claim 20 and the associated dependent claims 21-23, are patentable over Kinugasa and Fuwa et al. under the same rationale. Independent claim 20 specifically recites that the lean NO_x trap is to be formulated to include NH_3 generating materials and thus the lean NO_x trap itself is modified to optimize NH_3 generation so that the air/fuel ratio does not need to be adjusted to a rich one — as in Kinugasa.

Moreover, the Fuwa et al. reference teaches away from the claimed subject matter, as it requires the use of a three-way catalyst in contrast to the claimed subject matter wherein the lean NO_x trap is specifically modified to generate NH_3 for subsequent reaction and conversion of NH_3 and NO_x, as set forth in independent claims 1, 20 and 30. (Fuwa et al., col. 5, l. 52-Col. 6, l. 23.) As is well known in the art, for a traditional three-way catalyst if the air/fuel ratio is lean even by a small amount, NO_x conversion drops to low levels. Accordingly, the Fuwa et al. reference teaches away from the claimed invention.

In addition, claims 4-8 are separately allowable as the claimed zoned structure has not been disclosed by the combination of Kinugasa et al. and Fuwa et al. In support of the rejection, the Examiner states that:

> Fuwa discloses the conventionality of providing a control system in which the NO_X trap and the NH_3-SCR catalyst are alternating layers/zones in a single shell/substrate are mixed to form a single layer on one substrate. (Col. 25, l. 52; Col. 26, l. 7; Col. 27, ll. 13-23; Col. 30, l. 45-Col. 30, l. 6 in Figs. 39, 41a and 41b.)
>
> (Office Action dated July 5, 2006.)

A review of the cited passages from Fuwa et al. reveals that the claimed alternating zoned structure in claims 4-8 is not disclosed.

Accordingly, for the reasons provided, claims 2-8, 18 and 20-23 are allowable under 35 U.S.C. § 103(a) over Kinugasa et al. in view of Fuwa et al.

C. Claims 13 And 35 Are Patentable Over Kinugasa et al. In View Of Yamada et al. (U.S. Patent No. 6,221,804)

As both claims 13 and 35 depend from independent claims 1 and 30, for the reasons set forth above in Section A, the combination of the Kinugasa and Yamada references does not teach an emission control system that uses a modified lean NO_x trap to increase NH_3 production in combination with an NH_3-SCR catalyst to reduce NH_3 emissions and improve net NO_x conversion.

The fee of $500 as applicable under the provisions of 37 C.F.R. § 41.20(b)(2) is enclosed. Please charge any additional fee or credit any overpayment in connection with this filing to our Deposit Account No. 06-1510.

Respectfully submitted,

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Enclosure - Appendices

VIII. CLAIMS APPENDIX

1. An emission control system for controlling NOx and NH_3 emissions from an exhaust stream, the system comprising:

a lean NOx trap in communication with the exhaust stream for reducing NOx emissions, wherein the lean NOx trap is optimized for NH_3 generation by removing oxygen storage capacity of the lean NOx trap; and

a NH_3-SCR catalyst in communication with the exhaust stream for adsorbing NH_3, wherein the NH_3 adsorbed by the NH_3-SCR catalyst reacts with NOx in the exhaust stream to improve the reduction of NOx and NH_3.

2. The emission control system of claim 1, wherein one or more alternating layers of the lean NOx trap and the NH_3-SCR catalyst are provided in a single catalytic converter shell such that a top layer comprising the lean NOx trap positioned over a bottom layer comprising the NH_3-SCR catalyst is repeated one or more times.

3. The emission control system of claim 1, wherein one or more alternating layers of the lean NOx trap and NH_3-SCR catalyst are provided in a single substrate such that a top layer comprising the lean NOx trap positioned over a bottom layer comprising the NH_3-SCR catalyst is repeated one or more times.

4. The emission control system of claim 1, wherein one or more alternating zones of the lean NOx trap and NH_3-SCR catalyst are provided in a single catalytic converter shell such that an upstream zone comprising the lean NOx trap positioned upstream of a downstream zone comprising the NH_3-SCR catalyst is repeated one or more times.

5. The emission control system of claim 4, wherein each alternating zone of the lean NOx trap and alternating zone of the NH_3-SCR catalyst have a 1" length and 1" width.

6. The emission control system of claim 4, wherein each alternating zone of the lean NOx trap and alternating zone of the NH_3-SCR catalyst have a ½" length and a width of ½".

7. The emission control system of claim 4, wherein each alternating zone of the lean NOx trap and alternating zone of the NH_3-SCR catalyst have a length of ¼" and a width of ¼".

8. The emission control system of claim 1, wherein one or more alternating zones of the lean NOx trap and NH_3-SCR catalyst are provided in a single substrate such that an upstream zone comprising the lean NOx trap positioned upstream of a downstream zone comprising the NH_3-SCR catalyst is repeated one or more times.

9. The emission control system of claim 1, wherein the lean NOx trap generates a sufficient quantity of NH_3 to force the reaction between NOx and NH_3, whereby NH_3 emissions are eliminated and net NOx conversion improved.

10. The emission control system of claim 1, wherein the lean NOx trap is optimized for NH_3 generation by removing oxygen storage capacity of the lean NOx trap.

11. The emission control system of claim 1, wherein the lean NOx trap comprises a precious metal selected from the group consisting of platinum, palladium, rhodium and combinations thereof; and a NOx storage material selected from the group consisting of alkali metals, alkali earth metals, rare earth metals and combinations thereof.

12. The emission control system of claim 1, wherein the lean NOx trap comprises platinum.

13. The emission control system of claim 1, wherein the lean NOx trap comprises a composite of cerium and zirconium.

14. The emission control system of claim 1, wherein the lean NOx trap comprises one or more materials for NH_3 generating and NOx storage.

15. The emission control system of claim 1, wherein the NH_3-SCR catalyst comprises one or more NH_3 adsorbing materials, wherein the NH_3 adsorbing materials are capable of converting NOx and NH_3 to nitrogen.

16. The emission control system of claim 1, wherein the NH_3-SCR catalyst comprises a base metal and a support selected from the group consisting of alumina, silica titania, zeolite and their combinations.

17. The emission control system of claim 1, wherein the NH_3-SCR catalyst comprises a metal selected from the group consisting of Cu, Fe and Ce and a zeolite.

18. The emission control system of claim 1, wherein the lean NOx trap and the NH_3-SCR catalyst are placed in a single catalytic converter shell.

19. The emission control system of claim 1, wherein the NH_3-SCR catalyst is separate from and downstream from the lean NOx trap.

20. An emission control system for controlling NOx and NH_3 emissions from an exhaust stream produced by the combination of an air/fuel mixture in an internal combustion engine, the system comprising:

a lean NOx trap in communication with the exhaust stream for NOx reduction wherein the lean NOx trap comprises a lean NOx trap formulation which includes one or more NOx storage and NH_3 generating materials;

a NH_3-SCR catalyst in communication with the exhaust stream for adsorbing NH_3, wherein the NH_3-SCR catalyst comprises a NH_3-SCR catalyst formulation which includes one or more NH_3 adsorbing materials; and

wherein the lean NOx trap formulation and the NH_3-SCR catalyst formulation are placed on one substrate.

21. The emission control system of claim 20, wherein a layer of the lean NOx trap formulation and a layer of the NH_3-SCR catalyst formulation are placed on the substrate to form a two-layer washcoat.

22. The emission control system of claim 20, wherein the lean NOx trap formulation and the NH_3-SCR catalyst formulation are homogeneously mixed to form a single washcoat layer on the substrate.

23. The emission control system of claim 20, wherein the lean NOx trap formulation and the NH_3-SCR catalyst formulation are heterogeneously mixed to form a single washcoat layer on the substrate.

30. An emission control system for controlling NOx and NH_3 emissions from an exhaust stream produced by the combination of an air/fuel mixture in an internal combustion engine, the system comprising:

a lean NOx trap in communication with the exhaust stream for NOx reduction, to provide a NOx reducing exhaust stream including NOx and $NH_{3,}$ wherein the lean NOx trap is optimized for NH_3 generation by removing oxygen storage capacity; and

a NH_3-SCR catalyst in communication with the exhaust stream for adsorbing NH_3, wherein the NH_3 adsorbed by the NH_3-SCR catalyst reacts with NOx in the NOx reduced exhaust stream to improve the reduction of NOx and NH_3.

31. The emission control system of claim 30, wherein the lean NOx trap generates a sufficient quantity of NH_3 to force the reaction between NOx and NH_3**,** whereby NH_3 emissions are eliminated and net NOx conversion improved.

33. The emission control system of claim 30, wherein the lean NOx trap comprises a precious metal selected from the group consisting of platinum, palladium, rhodium and combinations thereof; and a NOx storage material selected from the group consisting of alkali metals, alkali earth metals, rare earth metals and combinations thereof.

35. The emission control system of claim 30, wherein the lean NOx trap comprises a composite of cerium and zirconium.

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None